Application Explorer Mission -A
Heat Capacity Mapping Mission
Progress Report

A) General situation

The following report reflects the status of the on-going HCMM investigations and it will discuss some problems with respect to the quality of data and related investigations.

Until now we have received several hundreds of HCMM images in form of positive and negative transparencies.
A critical review of all received images shows, that only a small part (about 30%) of the images can be directly applied for the planned and on-going investigations. This fact has to be related to severe cloud cover problems - espacially over the middle European test areas. In addition to that, many data especially the Night IR images are characterized by system noise and other recording problems.
A high percentage of delivered images cover other areas.
As it has already been mentioned earlier, the planned investigations in northern Germany which aimed at long term observations of the Ruhr district cannot be carried out due to the lack of required cloud-free data.
In many cases the photographic quality of the transparencies is very poor. In order to derive some information on the interpretability of these data, we had to use photographic technics in terms of " image enhancement ".

Until now we have concentrated our activities on two test sites located in Southern Germany and Marocco. Due to not jet settled decisions with a remote sensing group in Rabbat, the field activities are planned to take place towards the end of

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1980 or during spring 1981.
With respect to above two test sites we have carried out visual interpretations and started also with the application of digital image processing techniques due to a multitemporal approach. Because of lacking Night IR images on CCTs digital superimposition of multitemporal images is until now restricted to day IR iamges.

Test Area : Southern Bavaria (0815)

Data available : 1 CCT Night IR ID AA0038-3 3.6.78
5 Transp. 3.6.78
26.7.78
31.7.78
9.5.79
10.5.79

Above listed data have been visually interpreted with respect to the following objectives:
1) to obtain information about the meaning of day and night IR images with respect to geology, land use hydrology
2) to identify features uniquely exhibited by thermal information - in comparison with LANDSAT and field work.
3) to identify geo-scientific phenomena which will be investigated due to their thermal characteristics with respect to mapping purposes.

The selected area shows in the center the city of Munich.
It covers an area between the northern part of the alps and the jurassic series in the north which is gelogically described as Molasse basin.
This landscape with its manifold geo-morphological features and its land use pattern is typical for many middle European areas.
In the following chapter the results derived by a visual interpretation of images are being discussed from south to north.

Geologically the northern boarder of the Alps is characterized by a small belt of fine orogenic sediments (flysch). This geological unit, not detectable on images recorded within the visible wavelangth region can be clearly recognized throughout all available night IR images because of relatively high temperatures.(Fig. 1, 2 and 3)

The area of glaciation in the northern foreland of the Alps can be partly identified on the basis of night IR data. Especially the terminal moraines of various glacierization phases can be mapped (Würm,Riß, Mindel und Günz).
The relative dry and unsorted end moraine material consisting of cristalline components can be located through the vegetation cover due to higher temperatures.
The eastern part of the area of glaciation can be traced because of a reverse temperature effect. The lower temperatures are caused an increased soil moisture content within this area of glaciation, which is also characterized by a high clay-component.
Besides the upper Bavarian lakes - relicts from the lates glaciation , the night IR images clearly indicate the distribution of areas with high soil moisture such as swamps and bogs.

Uniquely identifiable on night IR images is the gelogical boarder of the upper fresh-water molasse in the northern part of the molasse basin north of Munich. This effect is also supposed to be related to the thermal behaviour of the underground material consisting of sand- gravel- and rubble deposits.
As a distinct feature, which can be located on day IR images of the dry season of the year are drift peat areas by the high tempearture relative to the environment.

The results of the preliminary interpretation do already demonstrate that small scale temperature information shows a high potential for the mapping of lithological features even through a surface highly impacted by land use activities.

	Landsat	HCMM night IR	HCMM day IR
Vegetation			
mixed forest	x	-	x
bog and peat	x	x	xx
deciduous forest	x	x	x
Geomorphology			
moraine district	xx	x	-
lakes	x	x	x
alluvial river beds	x	x	x
rivers	x	xxx	xxx
snow and glaciers	x	x	x
Topographic features			
cities	xx	x	xxx
urban areas and industrial areas	xxx	xxx	x
Geology			
flysh (orogenic sediment)	-	x	-
molasse	xxx	x	-

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x	very good
xx	good
xxx	fairly good
-	not detectable

Fig.1 Night IR 3.6.78 FROM CCT

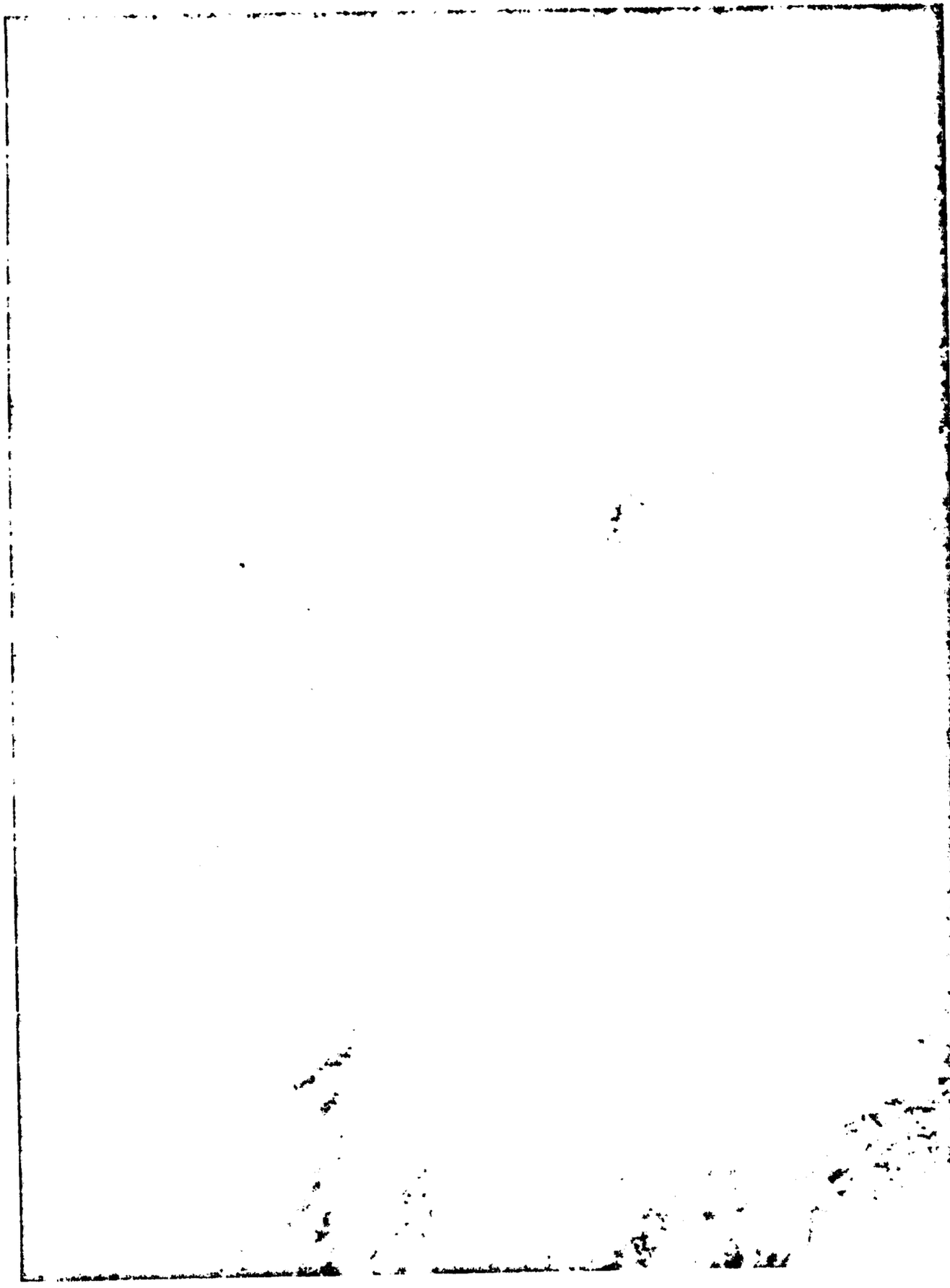


Fig 2. Night IR 9.5.79

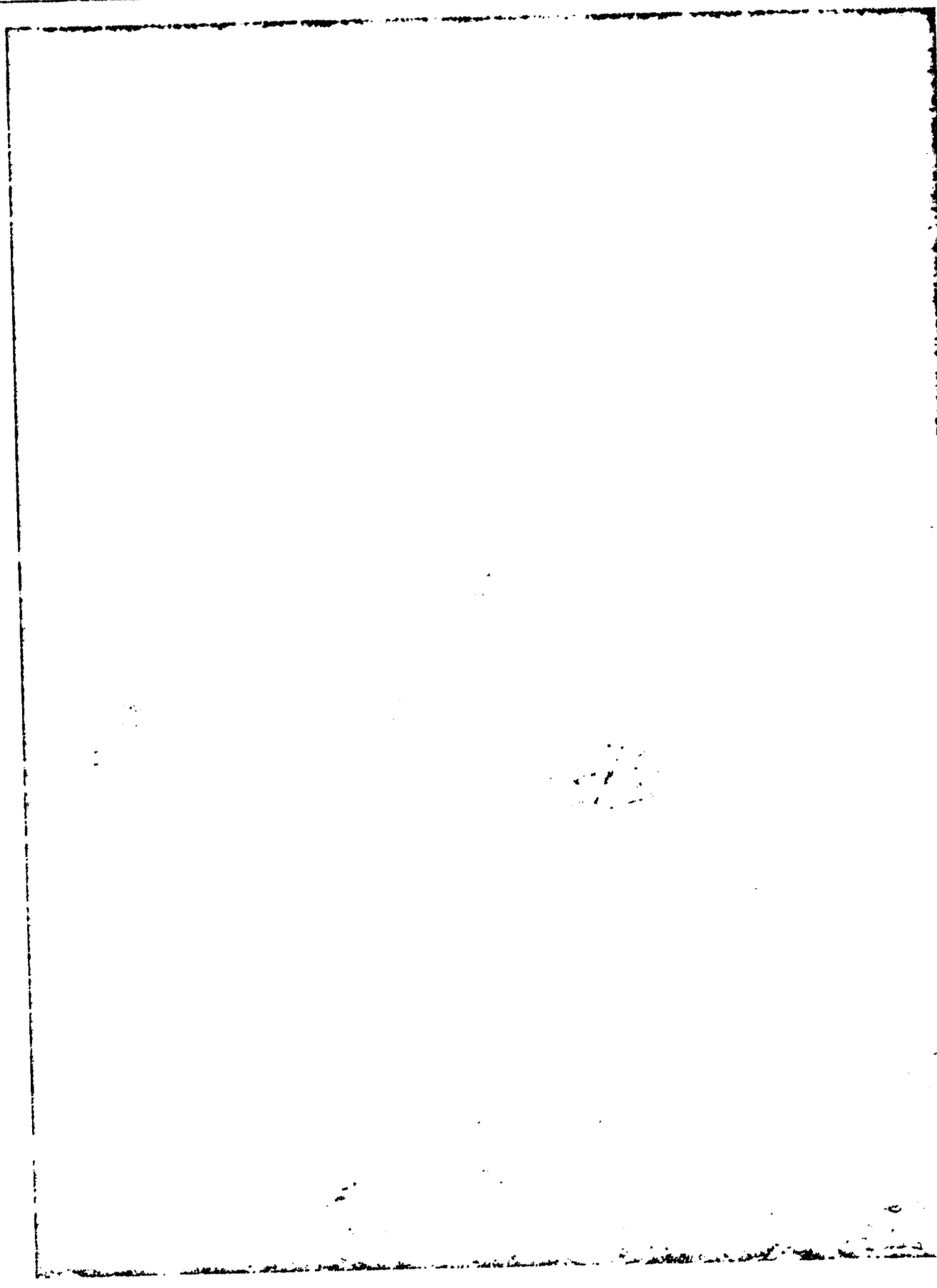
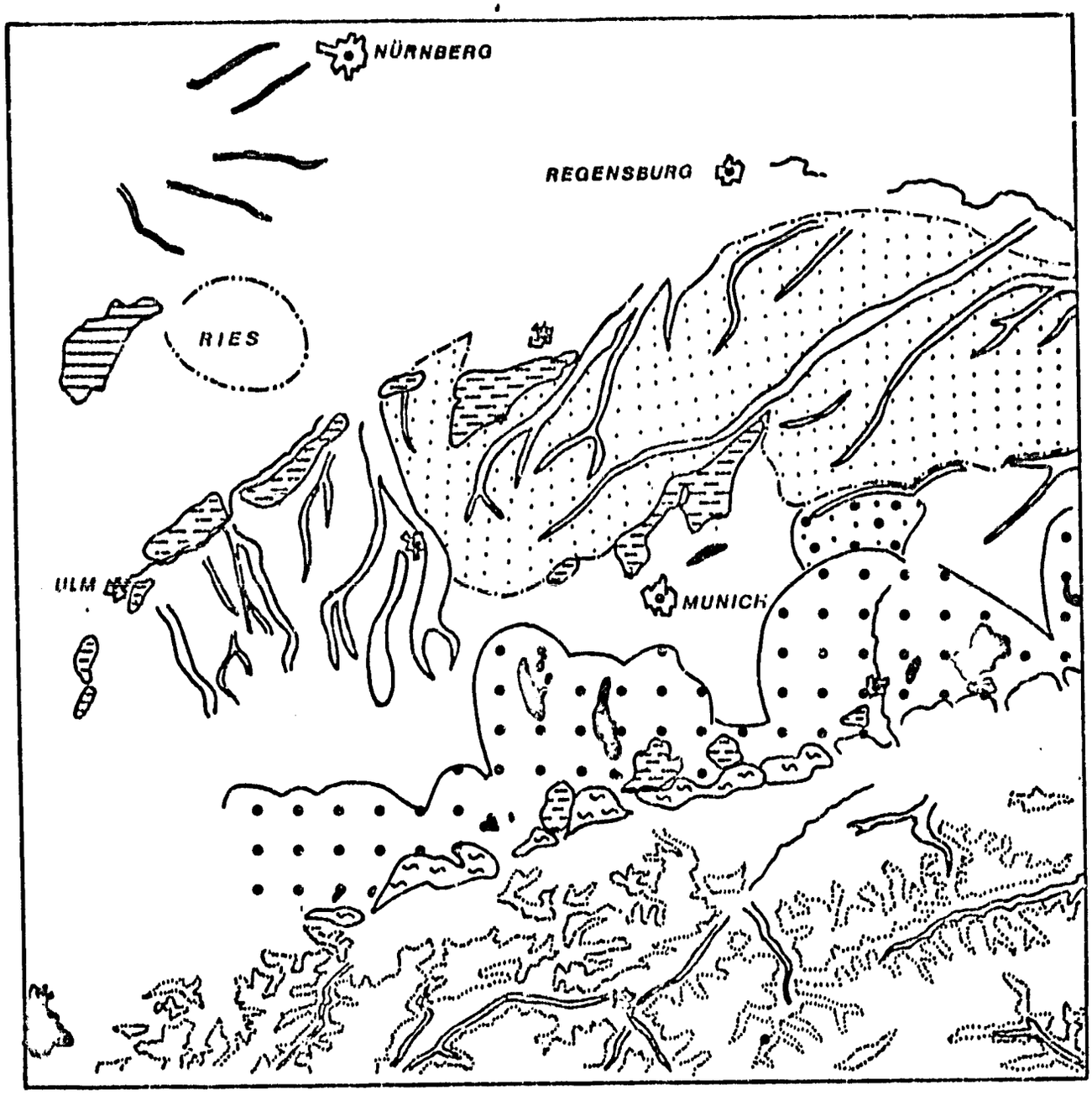


Fig. 3 Day IR 17.9.78

HCMM *TEST AREA 0815 (BAVARIA)* *GEO - MORPHOLOGY*



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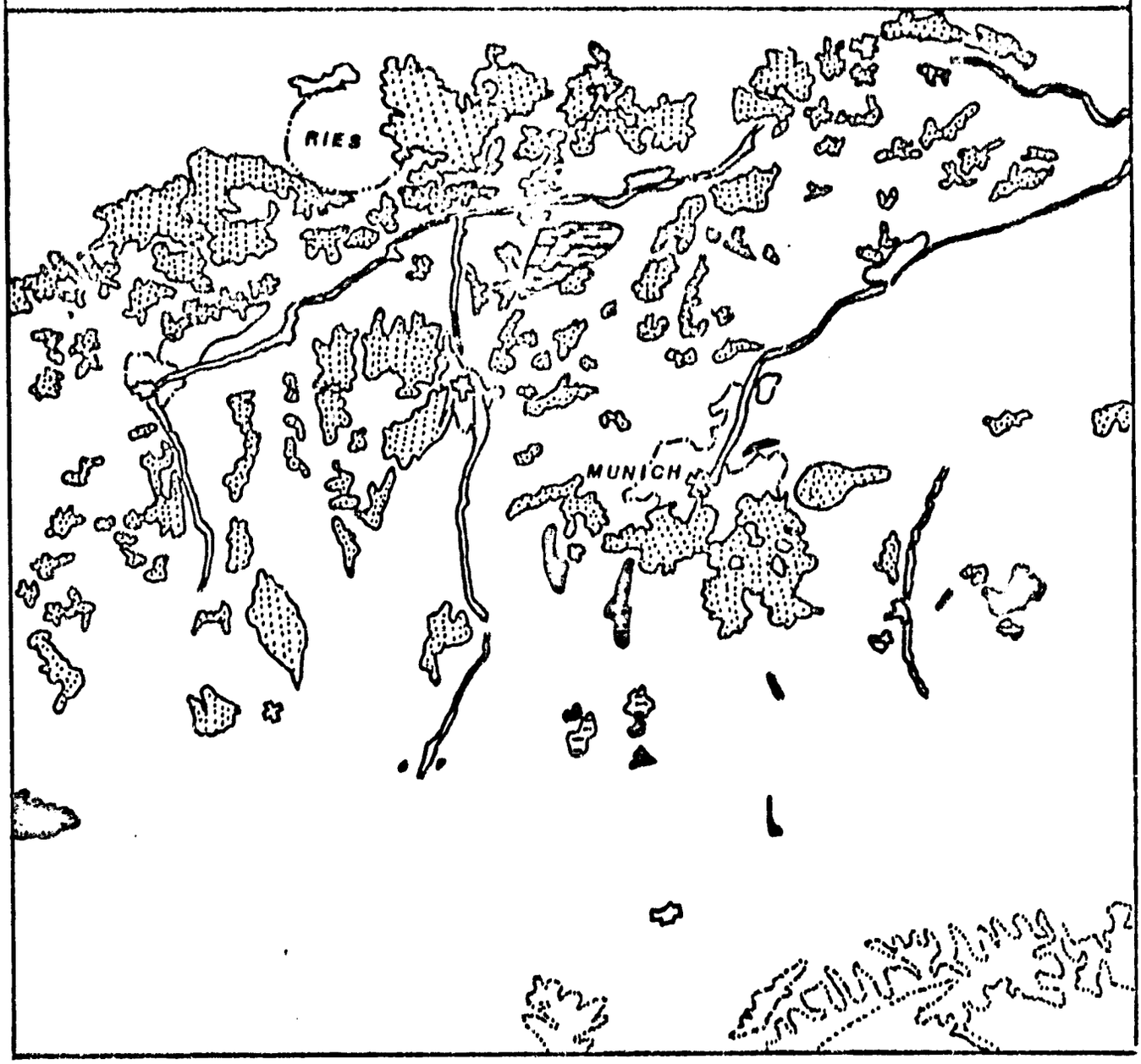
- *Snow covered areas*
- *city*
- *lake*
- *bog*
- *deciduous forest*
- *molasse*
- *flysh*
- *moraine district*
- *clouds*

NCMM TEST AREA OBIS BAVARIA DAY IR 17.Sept.78



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- mixed forest
- urban and industrial areas
- bog
- glacier
- city
- lake

Test Area : Marocco (2/04)

Data vailable :	7 CCTs Day Vis and Night IR
Dates :	18.5.78
	18.6.78 *
	6.9.78
	3.10.78
	30.10.78
	30.11.78
	12.1.79 *

For the described investigations we had to concentrate on image data acquired during day-time. Two CCTs available until now with night IR information could not be utilized because of cloud cover and qualtiy problems.
Under the limitations described the following investigations have been carried out to learn about :

1) possibilties to digitally superimpose multitemporal data to compare temperature readings
2) to investigate, if there are seasonal depending variations in the measured thermal information over various uncoverd geological units
3) to compare the interpretability of day IR data vesus information gathered in the reflective domaine (Landsat).

The described Maroccan test site is located SE of the City of Marrakech and covers a part of the High Atlas mountains.
The northern foreland of the Atlas is characterized by alluvial and quarternary deposits . The mountain chain consists of jurassic and cretaceous lime stone and marl complexes. Towards the western part they are replaced by permo-triassic sandstones and conglomerates accompanied by paleocoic shists and quarzites.
Because of the intensive relief and fast changing phenology

the interpretative evaluation of the images has been focused to the flat areas.
The southern continouation of the mountain chains is formed by a slightly southwards tilted plain of tertiary and quarternary sands.
The complex of the Anti Atlas is built up by precambrian igneous rock formations dissected by paleocoic shists and alluvial deposits. (Fig.1)

Results of visual interpretation

In order to investigate the gelogical information content of day IR images the CCTs listed above have been used to produce linearly contrast stretched images via the OPTRONICS photowrite system. Except for vegetated areas, the visual comparison of the various seasonal depending images did not exhibit characteristic changes of the recorded surface temperatures. In comparison to color information exhibited by the LANDSAT MSS 4 / MSS 5 Ratio image of Fig. 2 the relatively poor information content of day IR data due to lithological differenciations becomes obvious. (Fig.5).
The map of Fig. 4 demonstrates the main geological cathegories which could be delineated on thermal images of 2 dates (18.5.79 and 12.1.79).
In order to evaluate the possibilities of interpreting day IR data by looking at temporal changes, the same day IR images of August and Jannuary have been digitally superimposed.

Procedure of registration

The main problem in registering multitemporal images is the idenification of corresponding passpoints. The digitizing procedure was carried out by using a digitizing tablet connected to a HP-Table top calculator. By enlarging the images to a scale of approximately 1:500 000 before identifying the passpoints finally led to acceptable results.

Interpretation of Multitemporal data.

Having carried out the superimposition procedure several Intensity profiles have been plotted and compared.
The example described above corresponds to the profile plotted into the image of Fig.5.
The corresponding temperature profiles are shown by Fig 6 and 7. Besides an overall higher energy level measured during the summer time, the two profiles exhibit relatively high temperatures over the sand and gravel deposits. Temperature variations within the mountain region cannot be used for comparisons due to above mentioned relief effects. If we assume an identical overall energy level based on the profile readings covering the northern foreland of the Atlas, the following phenomenon can be observed. There is no distinct change in the tempearture readings except for the gravels and sand deposits, which are characterized by relativel higher temperatures with respect to the environmental behaviour. On a corresponsding linear combination shown by fig 8, this effect is demonstrated by the light grey tones also indicating the sand and gravel deposits within the cristalline Anti Atlas.
On the basis of this very preliminary results it is planned to systematically look at the seasonal temperature behaviour of various surfaces including night IR data and the required albedo information in order to define an empirical model which improves the interpretability of thermal information.

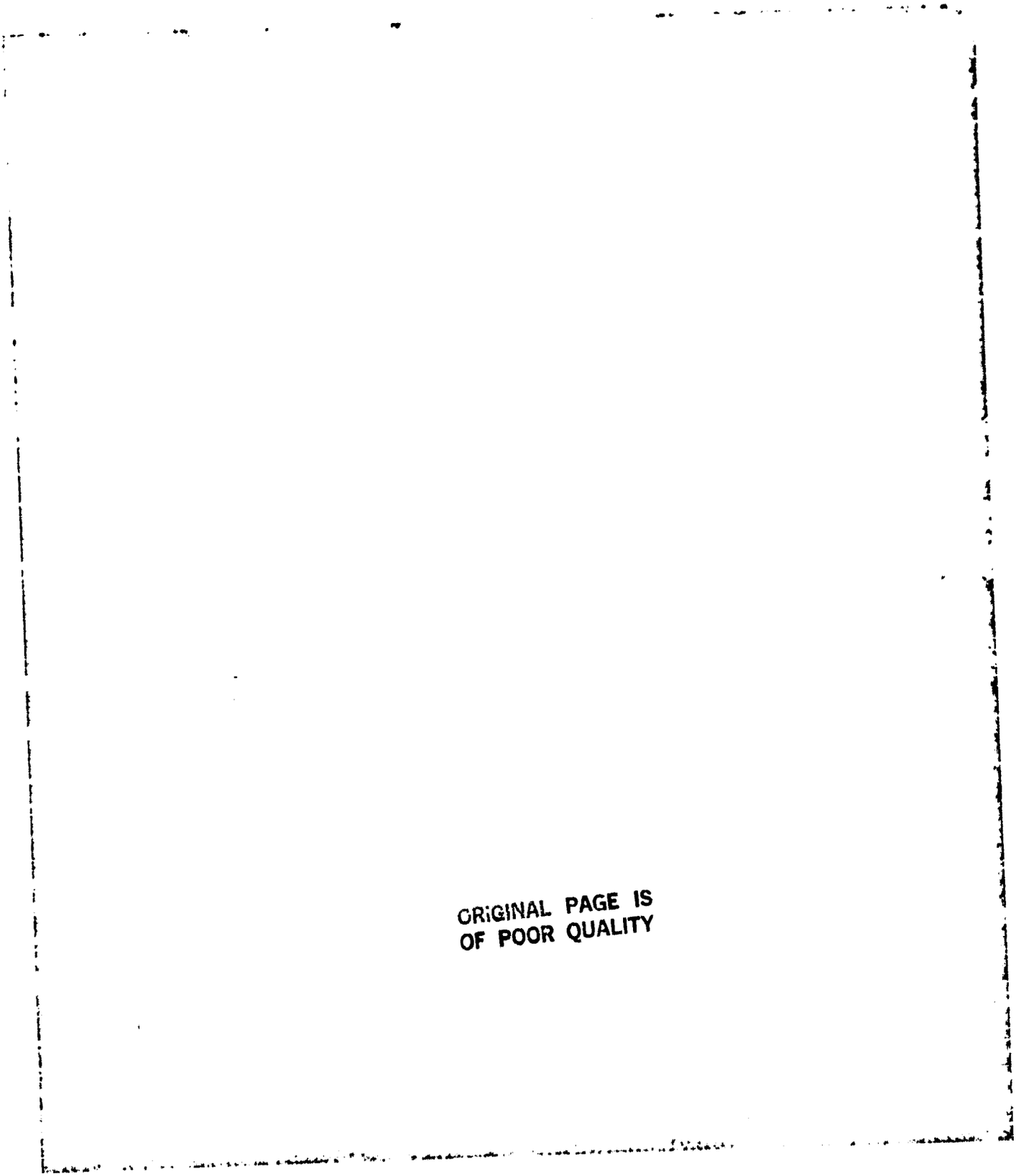

Fig. 1 HCMM DAY Vis exhibiting the test area.

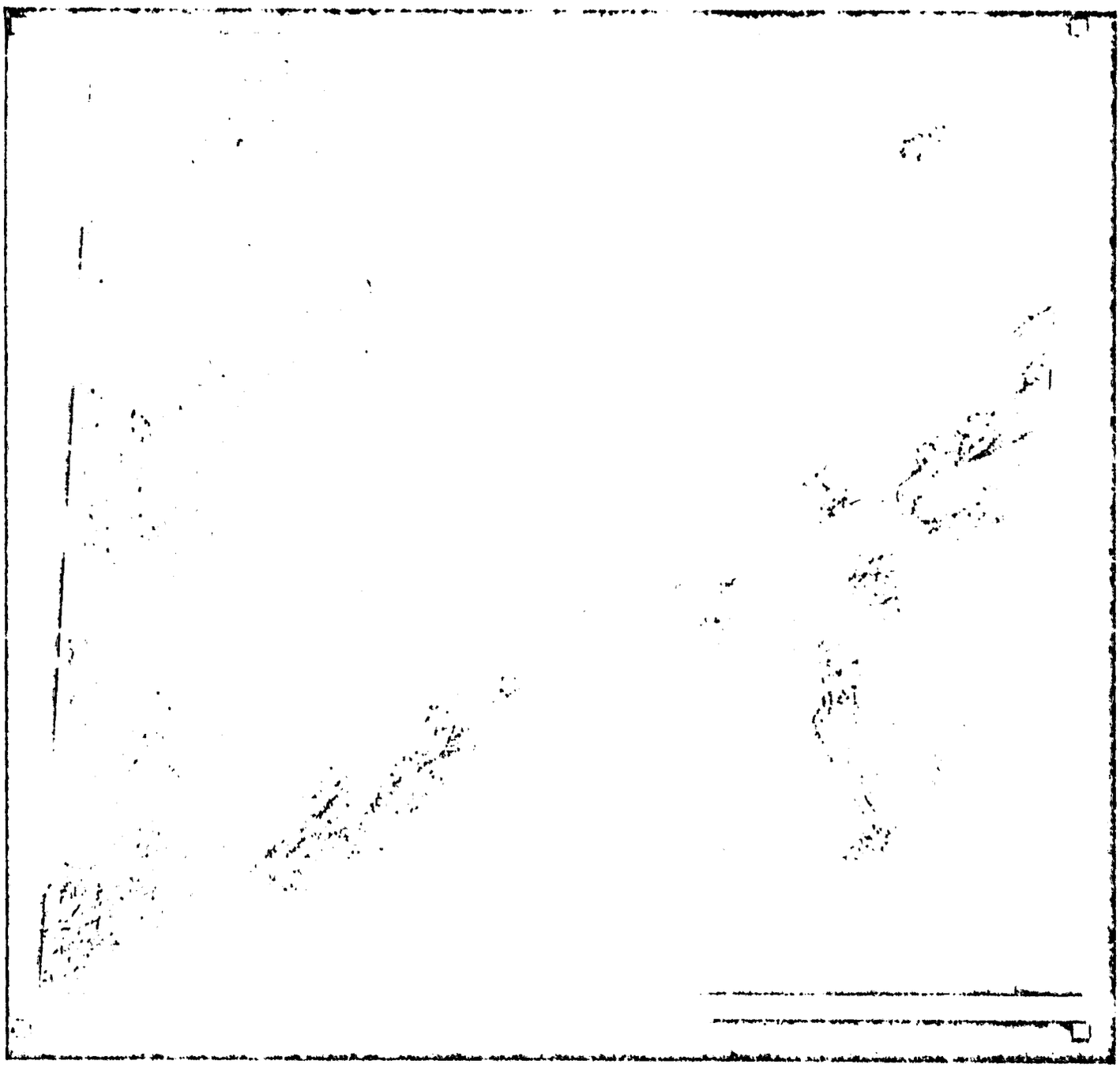

Fig. 2 LANDSAT MSS 4/5 Ratio

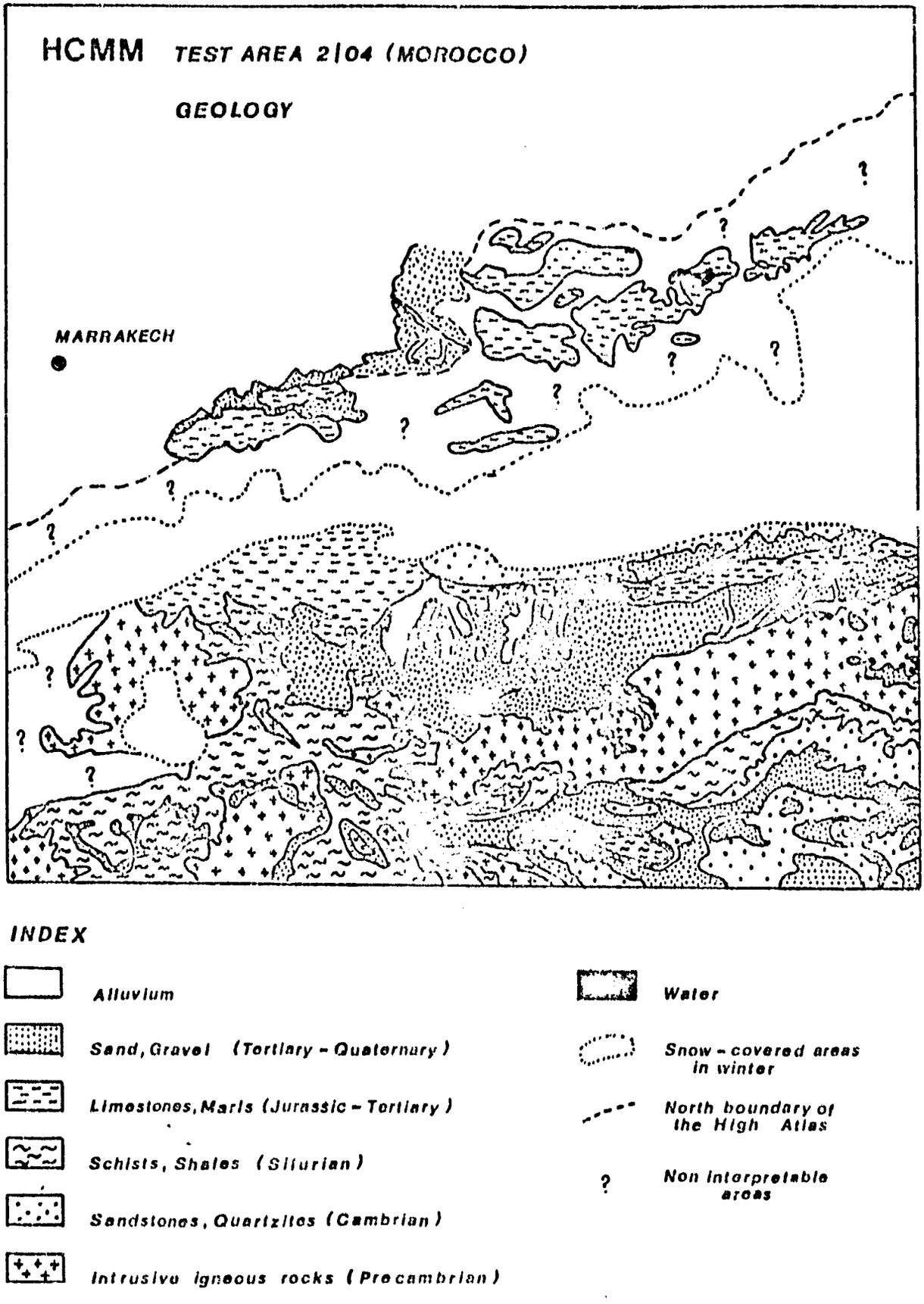

Fig. 4 Geological map derived from HCMM Day Vis data

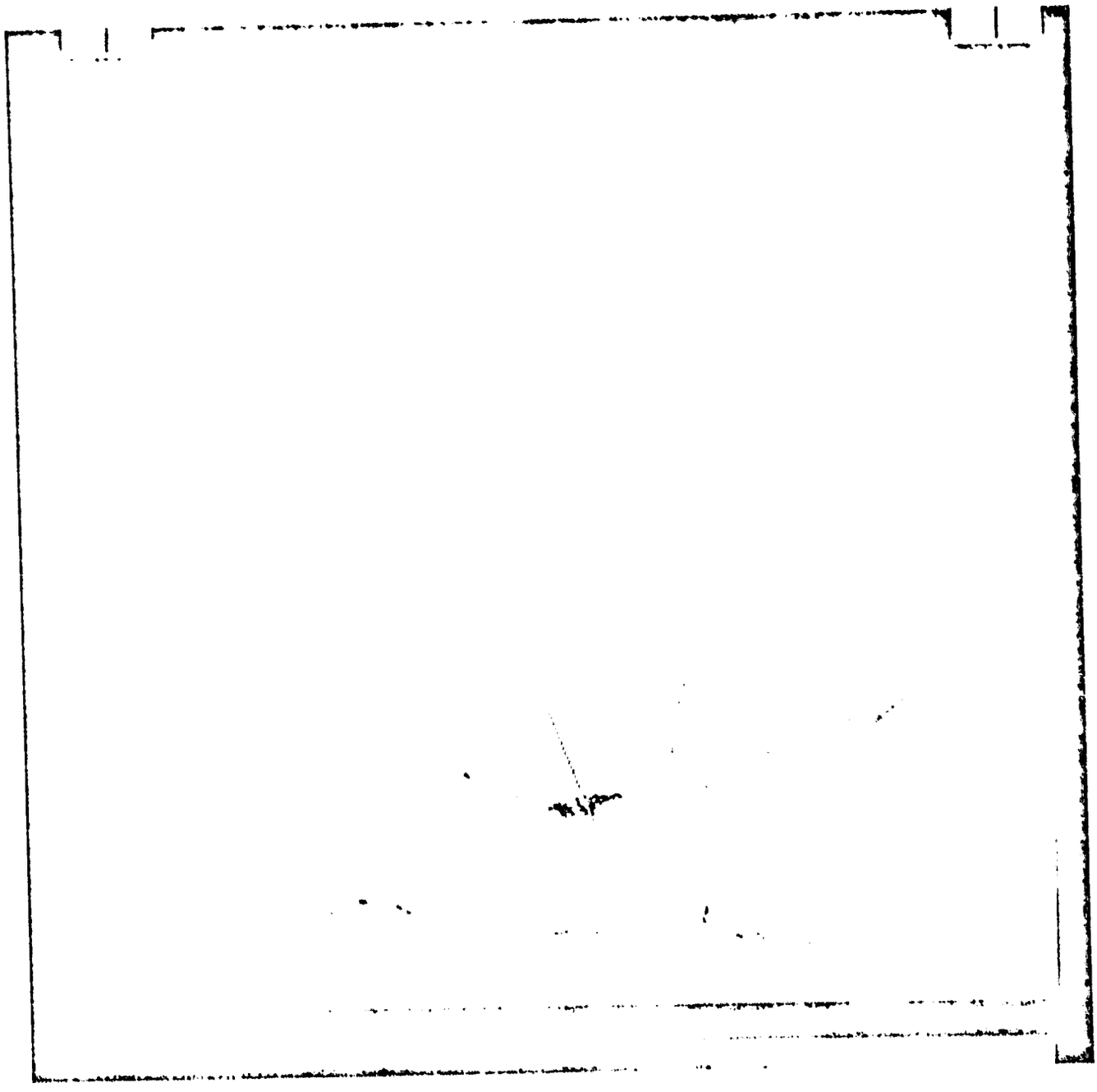

Fig 5 Position of Profile

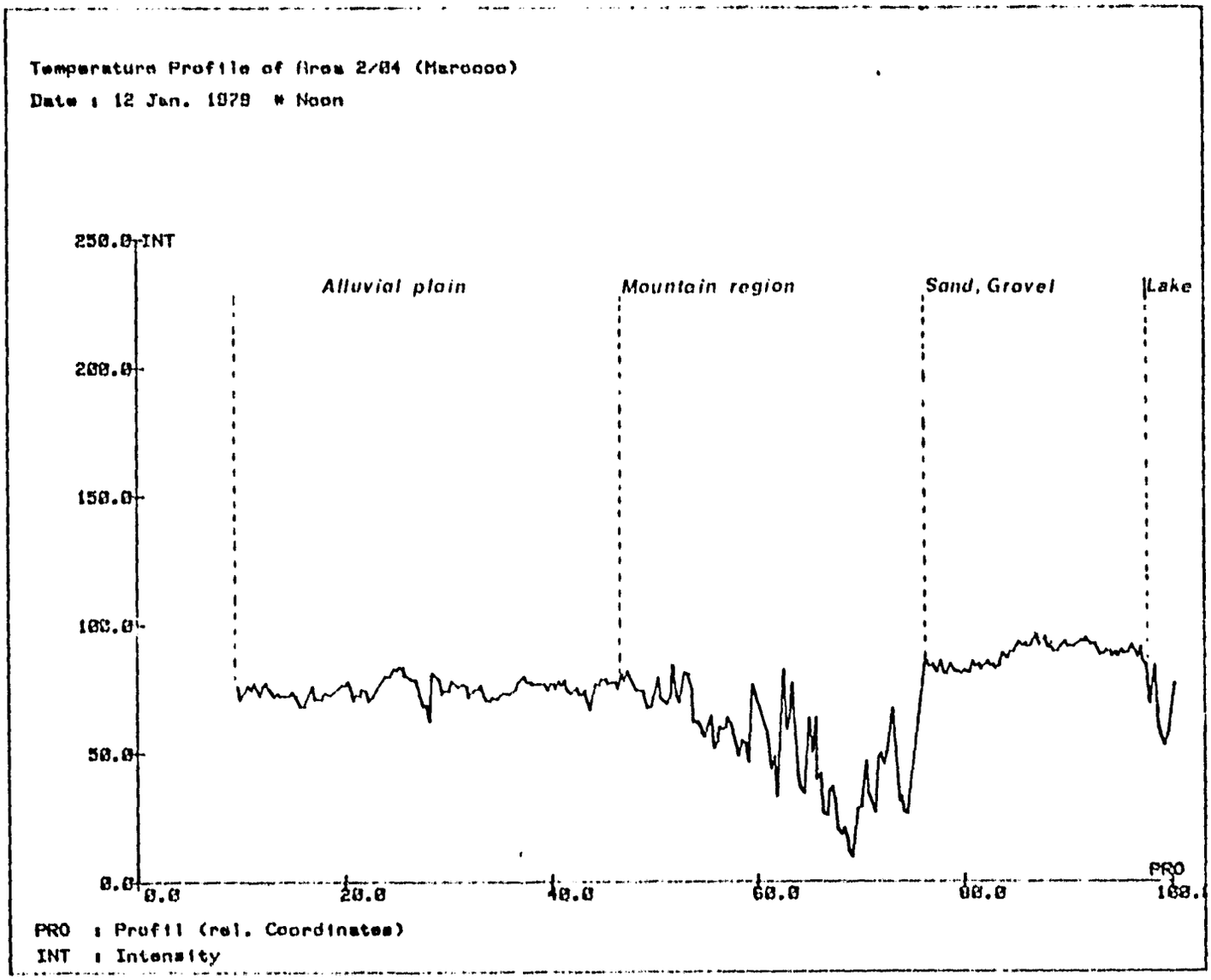
Temperature Profile of Area 2/84 (Morocco)
Date : 12 Jan. 1979 * Noon
250.0 INT
200.0
150.0
100.0
50.0
0.0
Alluvial plain
Mountain region
Sand, Gravel
Lake
0.0
20.0
40.0
60.0
80.0
100.
PRO
PRO : Profil (rel. Coordinates)
INT : Intensity

Fig.6

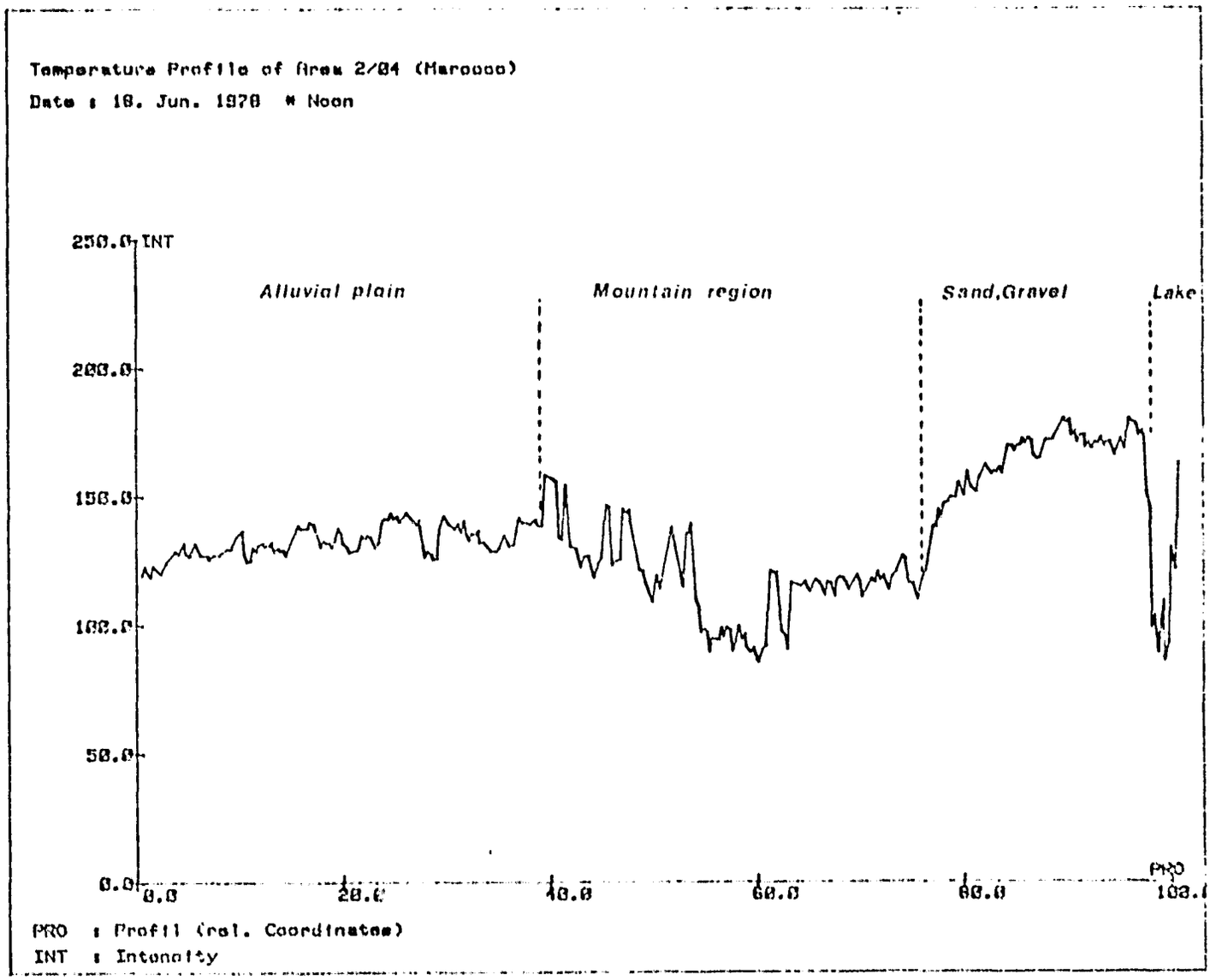
Temperature Profile of Area 2/84 (Morocco)
Date : 18. Jun. 1978 # Noon
250.0 INT
200.0
150.0
100.0
50.0
0.0
Alluvial plain
Mountain region
Sand,Gravel
Lake
0.0
20.0
40.0
60.0
80.0
PRO
PRO : Profil (rel. Coordinates)
INT : Intensity

Fig 7

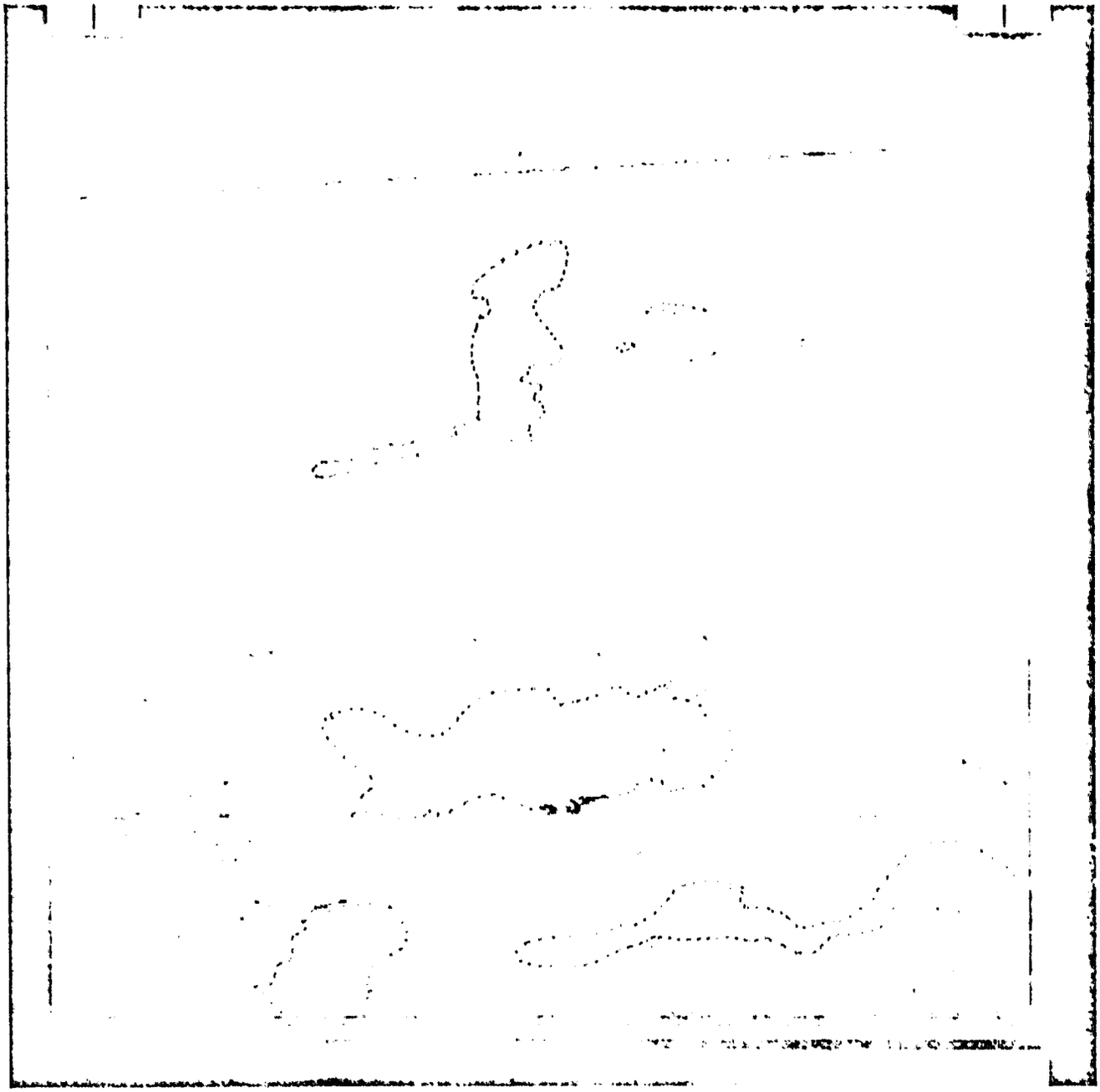

Fig. 8 Linear combination of HCMM image (June 78 and Jannuary 79)